

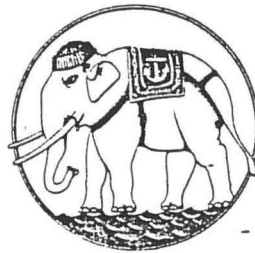




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CONDITIONAL SURVEY  
of ship  
BALCLUTHA

Preliminary Report  
on  
Assessment and Recommendations



**WHITE ELEPHANT MANAGEMENT**

*Caretakers of Maritime History*

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The Conditional Survey of the historic ship BALCLUTHA was performed intermittently, between December 1984 and March 1985, aboard the vessel in her berth at Pier 43, San Francisco. All accessible areas of the vessel were inspected. Additional inspection of the shell exterior will be done at the next drydocking.

This report represents a summary of our findings and is submitted at this time in order to draw attention to safety hazards and maintenance liabilities which we feel warrant timely attention. The detailed Survey Report is a separate document and will be submitted at a later date.

### INSPECTION

The survey is divided into three sections: Hull, Decks and Equipment, and Rig.

1. The hull survey consisted of:

- a) visual inspection of all exposed plating as well as structural members and their riveted attachments.
- b) hammer testing of cement bilge lining
- c) bottom inspection by diver
- d) measurement of hull electrical potential
- e) audiogauging of plate thickness, (over 1,500 readings taken)
- f) calculation of approximate section modulus, original and present.

2. The deck and equipment survey consisted of:

- a) visual inspection of all wooden structure
- b) hammer sounding and probing of all wooden structure
- c) electrical system survey
- d) visual inspection of deckhouses, deck furniture, railings, stairs, ladders, gangway, hatch coamings, catheads, capstans, pumps, chain stoppers, windlass and steering gear.

3. The rig survey consisted of:

- a) visual inspection of all spars, fittings, standing rigging, connections, as well as mast steps and partners.
- b) audiogauging of plate thickness in steel spars
- c) hammer sounding and probing of wood spars.
- d) stripping of some service, hammering off scale, and disassembly of one bottle screw.

## ASSESSMENT AND RECOMMENDATIONS

### 1. Hull

Completion of the hull survey must await drydocking for exterior examination of plating and audiogauging of previously installed doublers which cannot be gauged from within the vessel. W.E.M. will carry out this inspection at such time as the BALCLUTHA is drydocked.

Based on the inspection to date, which included over 1,500 plate thickness readings, we do not expect major shell renewals to be required at the upcoming drydocking. For such repairs as are needed please refer to the "Specifications for drydocking the historic ship BALCLUTHA", submitted by W.E.M. on 2/15/85. These specifications provided for obtaining quotations on various methods of renewal. The exact procedures are to be chosen by the Contracting Officer or his representative, after inspection of the vessel in drydock.

Our general recommendation was to continue the previously begun program of shell repair by welded doubler. This is the most cost effective and easiest method of repair which is suitable for the intended use of the ship as a permanently moored museum.

The hull girder strength is not critically low for the present usage of the vessel, but is estimated to be 50% or less of original strength. This weakness is partially due to loss of shell thickness but a major factor is the loss of riveted attachment of internal stringers, particularly at the main and tweendeck levels. Repair of these stringers would require partial removal of deck planking, waterway cement, and stringer plates. Riveted repair is feasible in these locations and can be accomplished with the vessel at her berth and open to the public.

The long term survivability of the ship can be greatly improved by such repairs and we recommend provision be made for this work in long range planning. We do not consider this to be a short term (1-5 yr.) priority.

The most critical present need for the preservation of the hull, aside from improvement of the present mooring system, is arresting ongoing corrosion, both inside and out. There are two primary requirements for achieving this. The first is renewal and upgrading of the coating and cathodic systems as recommended in the drydock specifications. The second is the basic one of keeping the water on the outside of the ship by means of eliminating above waterline leaks. This will be addressed in the next section on decks and equipment.

## 2. DECKS AND EQUIPMENT

The items listed below are those which require prompt correction to avoid the further rapid advancement of corrosion and decay. Items not representing a severe liability will be described in the main body of the survey report.

### a) F'csl head deck

This deck leaks like a seive but is not yet rotten. It is going soft on faying surfaces over beams and stringers. The planking is weathering badly and needs coating with an oil and wood preservative solution. This deck can still be saved for a fraction of the cost of renewal by recaulking as soon as possible.

### b) Main deck in F'csl.

There are numerous rot pockets which can be arrested by chemical treatment combined with correction of leaks in the deck above. No renewals are recommended at this time.

### c) Main deck

This deck is in poor condition with numerous areas of rot and leakage. Many areas show evidence of extensive corrosion of the underlying steel structure, and numerous planks have been pushed up by the expansion of rust scale.

The worst area is on centerline in way of the masts, hatches, and deckhouse. We recommend complete renewal of the centerline portion (approximately one third) of the deck. Proper repair and coating of the underlying steel structure will be essential to the success of this work.

The outboard portions of the main deck can probably be saved by selective renewal of about 15% of the planking and recaulking all seams.

### d) Main deck waterway

The cement in the waterway is not watertight as evidenced by the extensive corrosion of the underlying stringer plate and loss of attachment to the shell. We recommend recoating the waterway with a modern water proofing epoxy sealant.

### e) Poop deck

This deck was partially replanked and extensively recaulked in 1984. Leakage at present is slight, if any. To monitor the development of leaks the deck beams should be repainted to eliminate old stains. Any new leaks will be easy to spot by the attendant discoloration of the painted beams. Areas of soft planking still remain, under the mooring bitts located at the mizzen shrouds and under some of the taffrail stanchions. These

areas should be repaired to prevent the spread of rot.

f) Main deck under poop

Numerous rot pockets were found throughout this deck, and the margin plank along the break-of-poop is rotten. Some of these areas of rot are quite old. None are considered serious enough to warrant renewal. We recommend treatment with wood preservative and filling with plastic or epoxy compounds to give abrasion resistance.

g) Tweendeck

Numerous soft and some rotten areas were seen in the t'weendeck. This condition is largely the result of main deck leakage. Of primary concern is the area around the main hatch, where plank ends are rotten. None of the areas of rot are considered safety hazards at present. This deck can be retained for some years if the deterioration is stopped by correcting leaks in the main deck. The deteriorated areas should be repaired or renewed.

h) Electrical System

The electrical system presently installed in the BALCLUTHA is a 240 volt a.c., single-phase shore power system. An inspection of this system, conducted by W.E.M. and Schaus Engineering Services, revealed the following:

- Ground faults were detected on all three conductors of the shore power cable. This means that electrical current is passing from the hull to the pier, via the water, and could be causing damage to the hull.

- Numerous deficiencies were seen in the on-board electrical system, including: exposed wire connections, non-drip proof outlets and junction boxes, and improper wire runs. All of these conditions increase the possibility of electrocution and electrical fire, and should therefore be considered priority items.

- The main disconnect and fuse box, located on the pier is resting on unsound pier decking.

We recommend the installation of an isolation transformer. This would electrically isolate the vessel from the pier, and would eliminate the possibility of a.c. current damage to the hull.

Secondly, we suggest the upgrading of the ship-board electrical system to the minimum code requirement for "wet areas" (code requirements for domestic and commercial bathrooms, etc.). This would require the installation of GFCI's (ground fault circuit interrupters) which reduce the possibility of electrocution. We feel these steps are necessary due to the constant presence of moisture in this marine environment.

Thirdly, we advise placing the main disconnect box on a sounder

area of the pier, and surrounding the box with a fence or guard rail.

#### i) Deckhouse

The deck over the house is extensively rotten and in need of complete renewal. Successful renewal will require some repair to the steel stringer plates and boundary angle around the top perimeter of the deckhouse. Due to the visually prominent position of the structure, the retention of original material or the visual compatibility of renewals will require careful consideration.

There is heavy scale on the boundary angle connecting the house to the deck reinforcing plate. We recommend that the margin planks be removed and the boundary angle and plate scaled or spot sand blasted. The steel should then be coated and made smooth and flush with an epoxy filler compound. The purpose is to provide a smooth caulking seam which will make it much easier to keep this joint tight and avoid recurrence of the present situation. Renewal of the margin planks around the deck house will likely be necessary.

#### j) Portholes

The overwhelming majority of the portholes are plagued by defective or nonexistent gaskets and freely admit rain water, even when dogged shut. This is a case where a minimal investment in material and labor could arrest the costly ongoing deterioration of the vessel.

#### k) Fore and Main hatch covers

The fabric hatch covers on the fore and main hatches were seen to be leaking. At present, it rains half as hard inside as it does outside under these hatches. Renewal of the hatch covers is another case where a minimal investment can prevent costly damage to the ship. The nearly unchecked ingress of rain water is a serious destructive force at work upon the vessel.

### 3. RIG

We have identified several problems in the rig which we consider the most serious liabilities in the ship, constituting a safety hazard to staff and visitors.

In addition, the entire rig is long overdue for a major overhaul. The rig should be sent down, in a sequential fashion, for renewal of coatings and such repairs as may be necessary. If this program is begun soon, we believe that the majority of fittings, spars, and standing rigging can be retained. Delay will only increase the losses due to corrosion and decay, with a consequent exponential increase in the cost of repair. No other part of the ship is as vulnerable to neglect nor as severe in its potential consequences.

## Serious Deficiencies

In order of severity these are:

### a) Main Topmast

This spar is in the worst condition of any in the ship, yet it occupies a crucial central position in the rig, second in importance only to the main mast. The topmast is 56 ft. long and tapers from approximately 20 to 18 inches in diameter. The mast is built of two rolled steel plates, with an estimated original thickness of  $6/20$ " or .333 inches. The longitudinal seams are lapped and double "reel" riveted, and are approximately 45 degrees off the fore and aft centerline of the ship. The plates have alternating flush butts with triple riveted internal butt straps. There are two stiffening angles, riveted on opposing sides along the interior of the mast.

On the forward side of the mast, 12'6" below the topmast hounds, the mast has a perceptible kink forward at the top of a butt strap. There is an outward bulge across the girth of this plate, 1-1/2" in height, and projecting 1/4" out from the mast. The plate thickness in way of this distortion is between 1/16" and 3/16". This thinness coupled with the discontinuity of the cylindrical section make the mast vulnerable to buckling failure. The load of supporting the rig at this point is being carried almost entirely by the after plate, which still averages about 1/4" thickness.

The seriousness of this situation is greatly exacerbated in that the mast is in even worse condition at the next butt strap which is 7' farther down the mast. At this location, the aft plate of the mast is completely rusted through for about 7" of girth and only 1/16" to 3/16" thick in the remainder. This means that the entire load at this point is being carried by the forward half of the mast. The internal stiffening angles are judged to be completely ineffective due to lack of attachment. Along the length of the mast the rivet heads are observed to be drawn in below the plate surface indicating expansion of rust between the flange of the stiffener and the mast plate. In an area extending about 5' above the lower topsail crane band, several rivet heads have fallen out and the stiffening angle can be observed to be about 1/2" away from the plate on the inside. This degree of displacement indicates that in all likelihood, the other rivets are broken and the heads remain in place through the adhesion of rust and paint.

The deterioration seen in the topmast is equivalent to sawing halfway through a pipe in two separate and opposing locations. The tremendously weakened section is midway between the support offered by the lower and topmast rigging. This is the point of maximum bending moment in the spar.

Above this section is the weight of the topmast crosstrees, topmast rigging, the entire suspended weight of the upper tops'l yard and halyard, the t'gallant and royal mast and yards with their standing and running wire rigging. An exact weight take off will require much measurement of scantlings aloft but a rough estimate would be approximately 5 to 7 tons of tophammer above the weakened section. This is merely the static load of the dead weight of this gear. The compression of the rigging screws and dynamic loading from wind or vessel motion can far exceed this figure. Were the main topmast to fail, the fore and mizzen t'gallants would very likely come down with it because the braces are wire rope and lead to the main mast.

The likelihood of such failure is difficult to assess. The mast has been bent for many years, but how long the plates have been so thin is unknown. Even if the remaining material in the topmast is equal to the work of supporting the tophammer above, the mast is very vulnerable to sudden increases in dynamic loading such as may come from the ship surging heavily against the dock or being struck by another vessel.

While it may be possible to effect an in-place repair with welded doublers, we believe it to be a more prudent course of action to relieve the mast of as much weight as possible by sending down the royal and t'gallant yards, striking the main t'gallant mast, and sending down the upper tops'l yard. We recommend this be done as soon as possible.

The main topmast has recieved numerous doublers over the years and is a "patchwork quilt" of welded improvisation. Since the heel of the main mast also requires repair (see item 'd' of this section) we recommend that the mast be pulled from the ship and placed on a dock for a detailed examination, to determine the best method of repair.

#### b) Mizzen t'gallant mast

This mast has an area of rot on the port aft quarter, in way of the cap band. This area is the fulcrum of bending in this mast. The rotten area represents an estimated 40 degree segment over a length of about 4' and has probably penetrated to the core of the mast. A 4" knife blade can be sunk in to the hilt with no resistance.

The mast may be salvageable by removing all rotten wood and scarfing in a new section. In order to effect such repair, we recommend sending down the mizzen royal and t'gallant yards and striking the mast.

#### c) Ratlines and footropes

Some of the ratlines of the port fore topmast shrouds are hemp and are suspect. The majority of the ratline seizings on the lower rigging and futtock shrouds are hemp and are rotten. The ratlines on the lower rigging are iron bars and distribute the load over several seizings, which is probably why they haven't let go yet. We recommend renewal of all existing, hemp ratline seizings.

The footropes are all wire rope and are now secured to the yards with synthetic rope lashings. Until the survey, the lower and topsail yard footropes were secured with hemp lashings. During the course of the survey it was discovered that the stirrup and footrope lashings were rotten and, on more than one occasion, they parted under minimal load. Subsequently, the BALCLUTHA crew renewed all hemp footrope lashings with new nylon line.

The condition of the wire footropes is unknown, but suspect. The footropes are served and a proper inspection would require the removal of large amounts of service. The hemp serving has not been tarred for a long time and is rotten and coming adrift in many places, which may admit water to the wire. Footropes are so crucial that even healthy looking service should be stripped off every few years to examine the condition of the wire.

At Mystic Seaport, about 10 years ago, the fore topsail yard of the JOSEPH CONRAD was on the dock for routine maintenance. The footrope had been freshly tarred and the yard was soon to be crossed again when a rigger noticed a kink in the footrope. With a little twisting the wire rope broke in his hands. At some time over the years, the service had been allowed to dry out for want of tarring, and water had penetrated to the wire. The steel wire eventually corroded. No amount of subsequent good maintenance could remedy this. Only by chance had a sharp eye discovered the defective footrope before it dropped someone out of the rig.

We strongly recommend the renewal of all natural fiber ratlines and ratline seizings, and a thorough inspection of all footropes. This measure is essential to the safety of the crew when working aloft, and should be undertaken prior to commencing other work on the rig.

#### d) Main mast heel

Approximately 4'6" above the heel there is a line of corrosion extending around the entire girth of the mast. This wastage appears to have been caused by wet sand ballast laying against the mast in previous years.

Above the 4' 6" line, the mast plates average thicknesses of between .250 and .333 inches. The originally required scantling was .400 inches. Below this line, the starboard plate is extremely thin with numerous perforations where the material is completely rusted away. The after plate and the port plate

average about .200 inches. This means that the column has significantly less than half of the original material remaining in an area where the entire load of the rig is concentrated.

The keelson, which serves as the mast step, has corroded to the extent that the web was audioguaged at .250, less than half original thickness. Furthermore, the top plate is very thin and has about 1-1/2" of scale between it and the angle bars riveted to the web. This means that it is no longer functional as the top flange of the beam.

At some time in the past, a makeshift repair was carried out by welding additional angle bars longitudinally to the web of the keelson and welding vertical gusset plates athwartship to the mast, keelson, and floors. This repair was an effective way of preventing the mast from settling but does very little to restore the longitudinal strength and continuity of the keelson. The keelson is one of the principal structural members of the hull girder and it is particularly undesirable to have it be weakened almost exactly amidship.

It is possible to strengthen the main mast by welding doublers on in place. Considering the extent of needed repair to the topmast, which is integral to the main mast, and the desirability of repairing the keelson, we recommend pulling the mast and carrying out all repairs while the mast is ashore.

#### e) Fore royal yard

The port yardarm has an area of rotten wood on its upper surface outboard of the yardarm band. This rot may extend under the band. We do not believe this yard to be an immediate source of danger but recommend sending it down for repair in the next few months.

### Conclusion

Hull: The priority items here are: 1) improving the present mooring system, and 2) arresting the ongoing corrosion on both the interior and exterior of the hull. These two areas of concern are covered in the W.E.M. reports "Balclutha Mooring Recommendations", 3/15/85, and "Specifications for Drydocking", 2/15/85, and are presently being addressed by the N.P.S.

Decks and Equipment: The most important items here are: 1) upgrading the electrical system, and 2) stopping fresh water seepage.

Installation of an isolation transformer, and correction of electrical system deficiencies should be carried out as soon as possible. These steps will reduce the possibility of electrical accidents and prevent electrolytic damage to the hull.

All BALCLUTHA's decks need at least some degree of attention. The deckhouse top will need to be renewed, as well as large portions of the main deck.

Stopping the ingress of fresh water into the vessel by repairing weather decks, and replacing defective tarps and porthole gaskets, will do much to reduce the present rate of deterioration.

Rig: From this survey we conclude that the entire rig is long overdue for major maintenance, but salvageable if such work is done soon.

We believe the main topmast to be critically weak and to constitute a safety hazard to staff and visitors. We recommend relieving the topmast of the weight of all tophamper above as soon as possible. The topmast could then stand safely until such time as the entire mainmast can be pulled for repair.

We must state, however, that without disassembly of the rig, many questions will remain unanswered. Inspection of each piece of the rig, while on deck, was traditionally carried out as part of the routine maintenance of a vessel. We believe this method to be the only certain way to achieve both safety and preservation in the long term.

The BALCLUTHA crew are fully capable of performing all operations necessary to maintain the rig. However, the current overall condition of the ship requires so much work that it is unrealistic to expect the staff to effect an overhaul without major increases in work force. It may be efficient to achieve this increase in work force by contracting rather than hiring but either way, the work should be started soon and kept up as an ongoing process. With the exception of pulling the main mast, the overhaul of the rig is not shipyard work. It is seaman's work and ought to be done aboard.

We recommend developing a plan for overhauling the rig of the BALCLUTHA over the next three years, and establishing a cyclical maintenance program thereafter. W.E.M. is available for consultation and assistance in the development of such a plan.



